Design for the intelligent indoor guidance service for shopping mall based on TRIZ

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Design for the intelligent indoor guidance service for shopping mall based on TRIZ

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Abstract

With service innovation, the shopping mall industry should optimize their service process and provide more intelligent services to improve customer shopping experience, which serves as the catalyst for the industry development. To apply the service innovation to shopping mall, this study proposes a proposes a holistic service design approach based on TRIZ, termed as four Dimensions (4D) service design model which includes four kinds of design approaches, namely TRIZ (Theory of Inventive Problem Solving), QFD (Quality function deployment), service blueprint and service maturity model, from four different dimensions. 4D service design model is presented in research framework and validated by case study of intelligent shopping mall design of U shopping mall in Taipei. The case study includes four phases: background analysis (BA), problem definition (PD), the problem resolution (PR), and the solution evaluation (SE). In the problem definition stage, the service blueprint of the initial service process of the shopping mall will be presented, and the problems will be analyzed. In the service resolution stage, the TRIZ contradiction analysis and the service blueprint of the shopping mall as it existed is depicted from the principles of problem resolution. In the solution evaluation stage, new service process will be proposed in the form of service

blueprint, also, the maturity level of new service process is analyzed and compared to the existing process to figure out the capability of the new shopping services process. Furthermore, a shopping service app with six function modules is proposed. During the proof of service stage, the smart shopping app is proved to be useful in improving the customer shopping experience.

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Chapter 1. Introduction

1.1. Background

As the driver of the economy in Taiwan, tertiary industry today makes up 68.7 percent of GDP in 2014 and has become the most important part of economy development. In the worldwide, the importance of tertiary industry keeps increasing and in 2014 it makes up 70.49% of world total GDP [28]. The retail business remains one of the most important parts of tertiary industry, and its sales volume has broken through 4000 billion TWD. While there has been consistent growth in retail business, the shopping mall industry is facing tremendous difficulties under pressure from online shopping and increasingly high operating cost. The online shopping, which transforms the traditional shopping into viewing the products on the page, saves customers' much time and cost on the way. The convenience of comparison and payment brought by online shopping also eclipse the traditional shopping mall. However, the shopping experience coming from the touchable environment and physical products is the most apparent competitive advantage of the shopping mall, which means the improvement of the shopping experience is the crux of development. Thus, the service innovation for enhancement of interaction with customers and shopping experience is essential.

Customers will purchase only if they are attracted to the stores so the indoor guidance should be the first step for the patronage and profitability of shopping mall. However, it is regretful that most of the shopping malls do not perform well in this aspect. They always try to improve the product quality rather than the service convenience. The discounts may be attractive, but it cannot be delivered to the customers efficiently. Furthermore, obvious flaws exist in information transparency which leads to the embarrassing fact that the customers are unable to find the stores' location; they are even unaware of the existence of such a store. That explain why the intelligent service emphasis the indoor guidance.

Based on the above issues, U shopping mall, one of the leaders in Taiwan retail business, has decided to improve its service quality with service innovation. This study is based on the case of U shopping mall. The service process is presented with service blueprint and the problems are formulated and analyzed with TRIZ method (Theory of Inventive Problem Solving), which can analyze the contradiction between parameters and give direction to problem resolutions. Then the improvements are proposed and new service process is constructed with service blueprint. Furthermore, a new app and its function modules for intelligent service is designed.

1.2. Objective and Proposed Methodology

The shopping mall needs more intelligent and efficient service process to provide the customers with guidance, discounts and so on to attract them to the store. Attempting to enhance the intelligent level of shopping process and improve the shopping experience, this dissertation proposes a novel methodology and designs a new service system based on TRIZ. The goal is to extend the application of TRIZ to shopping service area and develop a model of smart shopping service design.

This study proposes a holistic service design approach based on TRIZ, named four Dimensions (4D) service design model which includes four kinds of design approaches, namely TRIZ, QFD, service blueprint and service maturity model, from different four dimensions and four phases. It divides service design process into four phases, and then integrates five different theories an appropriate, integrated service design approach based on TRIZ. The four phases, which including background analysis (BA), problem definition (PD), the problem resolution (PR), and the solution evaluation (SE), are linked to the respective service design methods, which are based on TRIZ, and combined with non-TRIZ service design methods.

1.3. Dissertation organization

This dissertation consists of 5 chapter. Chapter 1 is the general introduction of this

study. Chapter 2 introduces the concept of indoor guidance, TRIZ, QFD, service blueprint service maturity model and intelligent service based on IoT. Chapter 3 depicts the research framework of this study, which present the 4D service design model systematically by explaining the logic of the study and the relationships between the methodologies. Chapter 4 is the case study. It first depicts the existing service process with service blueprint and analyzes its disadvantages as well as the maturity level. Then, in the problem definition stage, it generates the customer demands with problem formulator and service design demands with TRIZ service parameters. In the problem resolution stage, it selects TRIZ service parameters with QFD and constructs the TRIZ contradiction matrix. In the solution evaluation stage, the service functions are figured out according to the service resolutions. The mobile app with six function modules is proposed by integrating the service functions to construct the new service process. Then it compares the maturity level between the new service process and the existing process. Also, the case study is validated by service proofing. Chapter 5 present the conclusion of this study, including the conclusion, contribution, limitation and the future work.

Chapter 2. Literature review

2.1. Indoor guidance

The indoor guidance is first used to assist the blind and visually impaired people. Liu and Makino [1] took Fluorescent Lights as the medium of an indoor guidance system, which can detect the walking speed and thus alter the signal. They used mobile devices to provide the blind with navigation through the indoor locations. In shopping service area, the indoor guidance aims at attracting customers to the store. The customers can be attracted by the maximum convenience and impressive discounts, the satisfaction after shopping is also involved in the factors to keep the customer loyalty to the store [2]. So, the key factor of indoor guidance is delivering the attracting discounts information to customers and providing detailed direction guidance so that it is convenient for customers to find the store location. Cheng and Lou [3] applied a RFID technology (Radio Frequency Identification) in indoor guidance. The system consisted of tags, RFID readers information system and every customer will be assigned a RFID tag. After selecting the current location and destination, the shortest path will be suggested by the guidance system. Every time the customers pass by the RFID reader, the guidance system will identify the customer position and notify them the directions. During the trial period, the average time of finding ways had been reduced by 50% percent with this indoor

guidance system. Omran Al Hammadi [4] has developed an Android-based indoor guidance system, which utilized the NFC (Near Field Communication) and QR Code technology, to show the navigation to customers on a smartphone. This system was much cheaper and convenient than the RFID-based system. In this study, the new service system will be designed to provide the customers with more real-time discounts and detailed 3D direction guidance to achieve the indoor guidance in the shopping mall.

2.2. TRIZ methodology

TRIZ is proposed by Altshuller in 1946 after studying one million of worldwide patents. First paper of TRIZ came out in 1956. The uniqueness of TRIZ is that it combines the studies of nature, society and artificial objects [5]. It can provide a systematic approach for ones who are with less experience but attempts to seek for innovative solutions with concepts of contradiction, evolution and resources [6]. Initially, it was mainly applied in the technical field to solve the engineering problems, but currently it can also be applied in non-technical fields, such as banking, marketing, management and education [7, 8]. Lee [7] has applied TRIZ method in combination with service blueprint in the service innovation of parking lot. They formulated and resolved the problems then reconstruct the service process and successfully decrease the time of parking cars. Altuntas and Yener [6] evaluate the service quality of healthcare center with SERVQUAL Scale and then applied

TRIZ method in resolving the problem to improve the service quality. Shahin and Iraj [8] had applied the combination of QFD and TRIZ in banking service. Gazman and Rahman [9] translated the TRIZ engineering parameters into service parameters so that it can be applied in the service area.

In a specified technical system, two parameters always restrict mutually, which means if one parameter is improved, the other parameter will get worse. This kind of conflict is called “technical contradiction” in TRIZ. There are 39 engineer parameters in TRIZ. The core of problem solving with TRIZ methodology is to identify the contradiction in the system, which means we must identify the improving parameters and worsening parameters among the 39 engineer parameters, and then eliminate the contradictions with 40 innovative principles. The corresponding principles are figured out with TRIZ contradiction matrix, the sample of the matrix is shown in Figure 2.1. For example, if the improving parameter is parameter 1 (Weight of Moving Object) and the worsening parameter is parameter 3 (Length of Moving Object), the corresponding TRIZ engineering parameters are No.15, No.8, No.29 and No 34.

		Worsening Feature				
		1: Weight of Moving Object	2: Weight of Stationary	3: Length of Moving Object	4: Length of Stationary	5: Area of Moving Object
Improving Feature	1: Weight of Moving Object	-	-	15, 8, 29, 34	-	29, 17, 38, 34
	2: Weight of Stationary	-	-	-	10, 1, 29, 35	-
	3: Length of Moving Object	8, 15, 29, 34	-	-	-	15, 17, 4
	4: Length of Stationary	-	35, 28, 40, 29	-	-	-
	5: Area of Moving Object	2, 17, 29, 4	-	14, 15, 18, 4	-	-

Figure 2.1. Sample of TRIZ contradiction matrix [6]

2.3. Service blueprint approach

The first description of service blueprint is proposed by G. Lynn Shostack [10] in 1984. Service blueprints visually depict objectives and steps in a service process to reduce the complexity and help clarify the process [11]. As a technique for innovation, service blueprint drills the complete service process down to tasks and methods with all the steps fully described which enable the managers to identify the current problems of the process [12]. The customers’ actions, front and back stage actions, support actions and physical evidence are also involved in interpreting the service delivery. Chen and Cheng [13] had combined service blueprint and ISO 9001 approach to improving the effectiveness of hospital patient service system and the customers’ satisfaction had been significantly enhanced due to the improvement of service quality. Julia N. Albrecht [11] applied service blueprint to depict the visitors’ tourism experience from the visitor management perspective. The limitations of services were separated and new micro mobility patterns were

proposed to reconstruct the service process, which significantly improves the visitor experience.

2.4. Service maturity model

Maturity is defined as the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective. The company can evaluate their current service capability with the service maturity model. Typically, higher maturity level can reduce the gap between the expected result and actual outcome, which means better performance [17]. The maturity model was first adopted in software industry. Alain and Jane [16] had applied the maturity model to evaluate the improvement in maintenance of software. They developed the software maintenance maturity model (SMmm) and improve the KPA from level 3 to level 5. Mahmud Akhter Shareef [15] explored the relationship between service maturity level and the adoption of e-Government. He found the factors that affected the citizen adoption varied in different stages of maturity level and he figured out 11 factors in 6 maturity level. Chai [17] had studied 54 Fortune 500 companies and proposed service maturity model. He identified the common features of the services provided by those successful companies, and then classified these features into four coherent categories, also called “process area”. The four categories are strategy management, knowledge management, customer involvement and process formalization. He divided each category into five levels, which is called “maturity

levels”, and constructed “service maturity grid” with the categories and service maturity levels. He evaluated the company service maturity with service maturity grid. The sample of service maturity grid is shown in Table 2.1

Table 2.1. Evaluation system of service maturity grid [17]

	Strategy mangement	Knowledge management	Customer involvement	Process formalization
Level 1	Few strategies	Little attention to knowledge management	Customers are not involved in service design	Few formal documentations
Level 2	Strategies are only shared among top managers and only regarded as financial problems	Knowledge creation and learning in individual level	Customers are only taken as the research objects	Plans and strategies are executed according to the formal regulations
Level 3	Strategies construction and resources allocation is based on valid forecast and planning	Employees share the insights with other staffs	Customers are involved in the early and late stages of service design	All projects are proved and organized in standard process
Level 4	Deep analysis of strategy to drive future success; very dynamic resources allocation	The knowledge creation in group level and the insights exchange among the groups	Customers are involved in all the stages of service design	Quantitative measurements are adopted in the organization management
Level 5	The strategies are conducted all for the future development and have positive effects on all levels of organization	The knowledge creation in organization level with every staff participates in	Customers become the long -term partners in service design	Organization is concerned about the continual improvement of process

2.5. QFD approach

In the 1960s, the concept of total quality control (TQC) was introduced to Japan and quickly adopted by Japanese automobile industry. But the quality control only began after the new products were being manufactured. With more and more importance attached to quality, the industry started to recognize the necessity of quality control in product design stage. In 1972, Akao first proposed the “hinshitsu

tenkai”, a method to deploy the assurance points needed in product design to guarantee the quality of entire production process. After integrating the quality chart and other quality management ideas of that time in Japan, this approach evolved to QD (quality deployment). By the middle of the 1970s, QD was combined with some concepts from value engineering and turned into QFD (quality function deployment) [18]. The QFD house, which was taken as the basic analysis tool of QFD, was proposed during this period. As an approach to identify the customer demands and correlates the demands with engineering characteristics, QFD is widely applied in the engineering field to improve the product quality and satisfy the customer demand. Paramond [19] had applied QFD approach in maintenance engineering. They collected the customer rating of the quality degree in product maintenance and design MQFD model, which was the combination of TPM (total productive maintenance) and QFD, to improve the maintenance quality. Chen and Weng [20] had constructed fuzzy goal programming models to evaluate the product design with QFD. The fuzzy approach was used to formulate the correlations between the design requirements and customer requirements. The fuzzy programming model can evaluate the fulfillment of design requirements. In recent year, with the development of service science, QFD method had been applied in service quality control. Bottani [21] had applied fuzzy QFD approach in logistics services to evaluate the relationship between the customer requirements in express service and the service design parameters.

2.6. IoT-based intelligent service

IoT (Internet of things) is the networking of physical devices, vehicles, buildings, and other items with electronics, software, sensors which enables these objects to collect and exchange data [29]. The concept of IoT was first mentioned in 1995, but it was widely paid attention after the development of RFID [30]. In recent years, IoT has been applied in manufacturing, architecture and service industry. The features of IoT make the traditional services more intelligent, since it can enhance the interaction between service devices and customers. By embedding the software and sensors in service devices, the service providers can easily collect and analyze the customer data and improve the service quality. To customers, they will find the real world and digital world are linked by IoT seamlessly [31]. Pratikkumar [29] proposed the Semantic Gateway as Service (SGS) to provide interoperability between IoT systems. Chen [31] proposed the intelligent service-integrated platform based on IOT technology using FCM and fuzzy QFD method. He provided a stable architecture for business information system and made the complicated relationship among IoT systems more precise so it would be easier for operator to make decisions. Fei [30] applied IoT system in cloud manufacturing (CMfg). He resolved the key problem of the implementation of CMfg by proposing a five-layered structure resource intelligent perception and access system based on IoT.

Chapter 3. Research framework

This study is based on TRIZ, service blueprint, QFD and service maturity grid. We present the service process and identify the existing problems with service blueprint; we select the significant requirements and functions with QFD; we generate the service resolution with TRIZ; we analyze the service maturity level with the service maturity model. Figure 3.1 shows the research framework of this study.

Figure 3.1. Research framework of this study

3.1. Problem analysis stage

In this stage, we use service blueprint to descript the shopping service process. Then we discuss with the shopping mall staffs and experts about the potential problems with the existing service process, thus, we can identify the failure points and waiting points of shopping services and mark them on the service blueprint. The sample of service blueprint is shown in Figure 3.2.

Figure 3.2. Sample of service blueprint

3.2. Problem definition stage

In this stage, we should identify the customer requirements and service design requirements of shopping services. There are two stages of identifying customer

requirements, namely problem formulation and result analysis. At the first stage, we can adopt problem formulator proposed by Chai [25] to construct the function diagram of certain service process. Chai identified the basic function components of the services and classified the service functions into useful functions and harmful functions. Chai also identified the relationships between these functions as cause-and-effect: a useful function can be the prerequisite to another useful function; a useful function can cause a harmful function; a harmful function can cause another harmful function; a harmful function can affect a useful function. The sample of function diagram is shown in Figure 3.3

Figure 3.3. Sample of function diagram [25]

In this study, we should identify the basic functions of shopping services and construct the function diagram accordingly. Based on the function diagram, we can propose problem statements to enhance the effectiveness of useful function and reduce the effectiveness of harmful functions. Consequently, problem formulator can decompose the complicated problems into a series of small problems. And in

result analysis stage, we can integrate the problem statements and clarify the directions of problem resolution. The customer requirements can be generated from these problem-solving directions.

Regarding service design requirements, since we design the services to improve the service process, so the service design requirements are generated according to the failure points and waiting points of service process. The service design requirements aim at eliminating the failure points and waiting points, every failure point and waiting point have corresponding service design requirements.

As what we have mentioned in section 2.2, TRIZ methodology can also be applied in solving problems in service design area. About how to apply TRIZ to service design domain, Lee [7] had converted 24 out of 39 TRIZ engineering parameters to service parameters, which is tested by Cochran's test for consistency. The comparison table of original TRIZ engineering parameters and service parameters are shown in Table 3.1

Table 3.1. Comparison table of original TRIZ engineering parameter and service parameter

TRIZ engineering parameter	TRIZ service parameter
No.9 Speed	Responsiveness
No.10 Force	Force of supply
No.11 Stress of the objects	Service stability
No. 12 Shape	Exterior
No.13 Stability of the object’s composition	Stability of service function
No.14 Strength	Professional knowledge and skill
No.15 Duration of action by a moving object	Duration
No.17 Temperature	Service attitude
No.18 Illumination intensity	Cleanness of environment
No.19 Use of energy by moving object	Labor-intensive Degree
No.21 Power	Efforts
No.23 Loss of substance	Perish ability
24.Loss of information	Unspecific information
No.25 Loss of Time	Loss of Time
No. 27 Reliability	Reliability
No.28 Measurement accuracy	Communication
No.29 Manufacturing precision	Precision of service delivery
No.30 External harm affects the object	External harmful elements
No.32 Ease of manufacture	Accessibility of service
No.33 Ease of operation	Service system operation
No.34 Ease of repair	Service ability
No.35 Adaptability or versatility	Elasticity
No.38 Level of automation	Service intelligent level
No.39 Productivity	Service performance

In this study, we present the service design requirements with TRIZ service parameters, which means that improving certain TRIZ service parameters helps eliminate failure points and waiting points of shopping service process.

3.3. Problem resolution stage

There are several cases of applying the combination of QFD and TRIZ in solving

service problems. Lee [23] selects the TRIZ service parameters with QFD and construct TRIZ contradiction matrix with these parameters to figure out the resolutions of catering services. However, Lee does not identify the worsening TRIZ parameters, which means he constructs the TRIZ contradiction matrix only with the improving parameters, it does not highlight the contradiction between two parameters. Furthermore, he only uses QFD to select the parameters, but not to select service resolutions. It is not reasonable, since there are always many potential resolutions of a single problem, but not all of them are suitable.

Considering the example, in this stage, we combine QFD approach with TRIZ contradiction matrix. With the customer requirements and service design requirements, we can deploy the first level QFD, in which the “whats” along the vertical axis mean customer requirements and the “hows” along the horizontal axis mean the service design requirements. Then we evaluate the significance of each parameter and select the most influential parameters as the **improving parameters**. The sample of QFD house is shown in Figure 3.4. In the sample, DR is the design requirement, CR is the customer requirement, k is the degree of importance, R_{ij} is the rating, and r_{jn} is the relation between two design requirements.

Figure 3.4. Sample of QFD house [20]

As what has been mentioned in section 2.2, if one parameter is improved, the other parameter will get worse. Accordingly, after identifying the improving parameters we can also identifying the corresponding worsening parameters. Then we can construct TRIZ contradiction matrix and figure out the innovation principles, which can be translated into service resolutions.

To implement the service resolutions, we need to generate several service functions and apply those functions to shopping service process. However, since not all the service functions are suitable to the shopping mall, we should select the most significant service functions with second level QFD. And then, we can integrate the service functions into function modules of shopping service mobile app. With the mobile app, we can reconstruct the service process of shopping mall. The new

shopping process is also presented in service blueprint.

3.4. Service evaluation stage

To evaluate the shopping service quality, we adopt the service maturity grid proposed by Chai [17] to evaluate the maturity level of specific service process. The current service capability of company is divided into four progress areas, namely 1) Strategy management, 2) Knowledge management, 3) Customer involvement and 4) Process formalization. In order to evaluate the maturity level more accurately, Chai make further efforts to divide four process area into 12 dimensions: the strategy management includes three dimensions, namely 1) Strategy goals, 2) Strategy specifications and 3) Resource distribution; the knowledge management includes three dimensions, namely 1) Organization culture, 2) Processes and 3) Service technology; the customer involvement includes three dimensions, namely 1) Customer role, 2) Involvement stages and 3) Involvement method; the process formalization includes three dimensions, namely 1) Systematic procedures, 2) Formal paperwork and 3) Responsibility assignment. The interpretation of these 12 dimensions will be shown in Table 3.2.

Table 3.2. Interpretation of 12 dimensions of progress areas [17]

Dimensions	Interpretations
Strategy goals	Company’s target in competition; How does the company communicate the goals and strategy to the employees.
Strategy specifications	Target customer analysis; Company’s competence in the target market.
Resource distribution	The resources that the company allocates to the optimization of all the projects in service design.
Organization culture	Organization’s awareness of the importance of the knowledge management and the information collection.
Processes	The methods of knowledge management and information sharing.
Service technology	The techniques adopted by the company in new services development.
Customer role	The customer role in service design; The active engagement level of customers in service development.
Involvement stages	The stages of service design that the customers are involved in
Involvement method	The methods adopted by company to involve customers in the service deign
Systematic procedures	The standardization and formalization of service design procedure.
Formal paperwork	The formal documentation of service design procedure
Responsibility assignment	There are explicit responsibilities of professional team in service design.

In this study, we evaluate the service maturity level of existing shopping process and the new service process in 12 dimensions of service maturity grid. The dimension with the lowest maturity level will decide the maturity level of the process area it belongs to. So that we can figure out the maturity level of the exsting and new shopping process. The service maturity level can reflect the service capability of the shopping mall.

Chapter 4. Case study

4.1. Background analysis

Located in Xinyi district, which is regarded as Taipei Manhattan, U shopping mall is one of the leaders in Taiwan retail business. Since it is mainly designed for female customers, especially the young official lady, U shopping mall has launched “Beauty Café” online services to provide top fashion information, personalized style customization and attractive discounts from various brands to female customers.

The environment of U shopping mall is also very impressive. Regarding the location, the B2 floor of U shopping mall connects with the transfer station, which makes it convenient for customers who take the public transport or even from the cities adjacent to Taipei. Regarding the layout, the decoration highlights the fashion sense with vivid colors and creative patterns combination. Additionally, U shopping mall arranges the cafés with different themes in every floor so that the customers can have a cup of coffee and a pleasant talk after they getting tired. Regarding the facilities, the cabinets with electronic code lock and free WIFI are available on every floor. The detailed floor introduction and direction guidance make it convenient for customers to plan the routes.

There are also many special services available in U shopping mall, for instance, the food court in the B2 floor, which is very famous in Taipei, integrates diversified cuisines from all over the world, such as Japan, France, and Thailand. The “Beauty Café” in 3F provides professional style and color consulting as well as a special fitting room to satisfy customer personalized demand.

To improve the shopping experience, U shopping mall attempted to adopt IoT-based service system, which aggregates the information of new products or real-time discounts and connects all the stores, to enhance the interaction between stores and customers. However, there are still many customer complaints about the service quality, including the difficulty in finding the store location, difficulty in finding the parking space, difficulty to find a suitable restaurant, etc. In order to satisfy the customer demand, U shopping mall decides to reconstruct its service process with service innovation based on IoT system. Thus, we design the new service system that can restructure the new process for U shopping mall as an empirical case study with TRIZ method, service blueprint approach, SERVQUAL Scale and QFD.

4.2. Existing service process analysis

The current service process of U shopping mall, including the physical characterization, customers’ action, staff actions and support activities, is depicted

with the service blueprint and shown in Figure 4.1. The service process includes seven phases: gain information, arriving, introduction, store reception, payment, catering service and leave. Then the existing service process will be described according to the above seven phases.

In the first phase, customers will obtain the information of stores, brands or services of shopping mall and they may enter the shopping mall only when they are attracted by the introduction. Typically, shopping mall sends the introduction to customers in traditional ways, such as official website, flyers, and billboards, which may be not effective since customers seldom visit the shopping mall website and may not notice the advertisements.

If customers decide to visit the shopping mall, the ones who take the subway or bus will directly get to the gate. However, customers who drive must find the parking space at first. Since there is neither screen nor detailed direction guidance showing the location of available parking space, customers must cycle around the parking lot to find parking space. If this floor is full, they have to go to another floor and try again.

After parking the cars, customers should enter the shopping mall. With “My Wall” system, from which the customers can get in touch with the introduction of

specialized products, services, and promotions provided by all the stores, it is possible for them to figure out something attractive and then they will head to the relevant floor to find those products and services.

To find the store location the customers may need the guidance from introduction booklet. However, the booklet is unable to provide routines since it only shows the layout rather than the detailed directions. When customers enter the stores, they tend to have trials. If they are willing to buy, the assistants should make invoices; if they are not satisfied, they will find another attracting store. Sometimes, even though customers have found the products they want, some other suitable goods are still needed to match with those products or maximize the discounts. Unfortunately, since most of the staffs only recommend the goods in their stores, it is not easy for customers to find out suitable goods of other stores.

After receiving the invoices, customers can make payment in the way they select at the cashier desk, where they may wait in queue for a long time. When customers finish the payment, they can get consumption points, souvenirs or parking deductions in return. But according to our observation, there are quite a lot of customers forgetting to take those rewards after payment.

Usually, customers would like to have meals after shopping, so the catering service is also a pivotal component of shopping services. To find the satisfying restaurants, customers need various kinds of information, such as the description of courses, environment, service attitude, length of the queue, etc. After that, customers will order the meal and have the meal. Many restaurants provide special discounts to customers who have member cards and coupons, however many customers always forget to bring those small items so they can not enjoy the discounts when they make payment.

In the final stage, customers will leave the shopping mall. To customers who walk they will just head to the first floor, find the gate and leave the mall. To customers who take the public transportation such as bus or subway, they can go to the B2 floor to find the transfer station. To customers who drive they will go back to the parking lot to find their cars. But, since the parking lot is huge, the elevator that customers take may be far away from the location of their cars, which make finding cars back more difficult. Before customers leave the shopping mall, they have to pay for the parking fee, which means they have to stop one by one in front of the fence machine and it is likely to cause traffic jam.

Figure 4.1. Service blueprint of existing service process of shopping mall

After depicting the service process, we interview the manager of customer service department in U shopping mall and several experts about their ideas of the potential problems of the existing service process. We combine the experts' opinions with our own observation and identify seven failure points and three waiting points, which impose adverse effects on the customers' shopping experience, can be figured out and marked in Figure 4.1.

- Failure point 1 (F1): unable to get the information of shopping mall. Since customers seldom visit the shopping mall website and may not notice the billboard, it is not an effective way to provide the information in such traditional ways. If customers can not receive the attracting introduction, they may not enter the shopping mall.
- Waiting point 1 (W1): too much waiting time in finding parking space. It always takes a long time for customers to find the available parking space since typically there is no obvious guidance, so they have to cycle around the parking lot.
- Failure point 2 (F2): difficult to find store location. It is always difficult for customers to find a specific store in such a big shopping mall since the introduction booklet only shows the layout of the shopping mall rather than the precise routes.
- Failure point 3 (F3): difficult to find suitable goods. After gaining the satisfying products in a single store, many customers still want suitable

goods from other stores to match with what they have got or to maximize the discounts. However, it is hard for them to find out the optimized portfolio of products since most of staffs only recommend the goods from their own stores.

- Waiting point 2 (W2): too much waiting time in making payment. Waiting in the queue at the cashier desk always takes customers a lot of time particularly at the high peak.
- Failure point 4 (F4): failure to get deductions. Since the staffs seldom ask if customers need deductions, sometimes customers will forget to obtain the deductions or coupons after payment.
- Failure point 5 (F5): difficult to find suitable restaurant. It is always difficult for customers to find a suitable restaurant since they are unable to get detailed information of rating of courses, environment, service attitude and length of the queue, etc.
- Failure point 6 (F6): failure to get discounts. Sometimes customers will forget to take the coupons or member cards so they can not enjoy the special discount for members.
- Failure point 7 (F7): difficult to find cars back. Since the parking lot is huge, and the elevator that customers take may be far away from their cars, it may be difficult for customers to find back their cars.

- Waiting point 3 (W3): too much waiting time at the exit. Customers have to stop at the fence machine to insert their parking card and then wait for the staffs to calculate their parking fee and make payment. It will take a long time and cause a traffic jam at the exit of parking lot.

4.3. The maturity level analysis of existing service process

As what has been mentioned in section 3.4, we will adopt service maturity grid proposed by Chai [17] to evaluate the service maturity level of the existing service process. Then we will evaluate the maturity level of these 12 dimensions, including strategy goals, strategy specifications, resource distribution, organization culture, processes, service technology, customer role, involvement stages, involvement method, systematic procedures, normal paperwork and responsibility assignment, to justify the current service capability of U shopping mall.

- Regarding “strategy goals”, U shopping mall is one of the leaders in Taiwan retail business and they are aware that if they want to obtain competitive advantage against the competitors, they have to adopt new service system and reconstruct service process. The goals are quite explicit and understood by employees. Accordingly, the maturity level of this dimension is level 4.
- Regarding “strategy specification”, U shopping mall has done a lot of research on their target customer (the female customers between 18 to 35,

especially the official lady) and designed a series of special service for them, so the market uncertainty is relatively small. Accordingly, the maturity level of this dimension is level 4.

- Regarding resource distribution, the resources in U shopping mall are relatively dispersed since the operation of stores is highly independent and there is not enough financial support to update the facilities and improve the service quality in the whole shopping mall. Accordingly, the maturity level of this dimension is level 2.
- Regarding systematic procedure, the service process of U shopping mall is highly standardized with strict regulation on products and service attitude. There is also a standard process of new service design and development. Accordingly, the maturity level of this dimension is level 3.
- Regarding formal paperwork, In U shopping mall there are formal booklets about the regulation, the service attitude, and the guidance, etc. Accordingly, the maturity of this dimension is level 3.
- In terms of responsibility assignment, U shopping mall possesses well-trained staffs for service design and service quality control with primary responsibility. But they still need the professional team to take the responsibility for new service development and service process reconstruction. Accordingly, the maturity level of this dimension is level 2.

- Regarding organization culture, U shopping mall has paid attention to service knowledge creation and emphasizes the collection of service records, which can be applied in the evaluation of service quality. The evaluation results will also be shared among the staffs. Accordingly, the maturity level of this dimension is level 4.
- Regarding processes, the service knowledge creation is mainly based on the record of experienced staffs or customer interview and the knowledge is shared through the conference or informal communication among the staffs. The shopping mall needs more efficient ways to obtain and share service knowledge. Accordingly, the maturity level of this dimension is level 2.
- Regarding service technology, although U shopping mall has adopted IoT-based service facilities such as “My Wall” system, the service intelligence still needs to be improved to resolve the customer complaints in shopping experience. More advanced technology is needed to update the service system and the approaches to knowledge creation. Accordingly, the maturity level of this dimension is level 3.
- Regarding customer role, currently, U shopping mall takes customers as the research objects and the source of information. The services are designed and improved according to the research on customers. Accordingly, the maturity level of this dimension is level 3.

- Regarding involvement stages, U shopping mall takes customers as the research objects. Then, the new services are developed according to the research outcomes and the services are evaluated according to the customer feedback, which means the customers are involved in the early and late stages of services development. Accordingly, the maturity level of this dimension is level 3.
- Regarding involvement method, U shopping mall may use interview, questionnaire and web statistics to collect customer demand and the need analysis techniques are direct and structured. Accordingly, the maturity level of this dimension is level 3.

The radar chart of current service capability is shown in Figure 4.2. It can provide an overview of company’s strength and weakness.

Figure 4.2. Current service capability

According to the maturity level evaluation of 12 dimensions, we can figure out the maturity grid of current service process in Table 4.1.

Table 4.1. Maturity grid of current service process

Maturity level	Category			
	Strategy management	Process formalization	Knowledge management	Customer involvement
Maturity level 1	Achieved	Achieved	Achieved	Achieved
Maturity level 2	Achieved	Achieved	Achieved	Achieved
Maturity level 3				Achieved
Maturity level 4				
Maturity level 5				

It can be inferred that the maturity level of current service process only attains level 2 and it is relatively low, which means the service capability of U shopping mall need to be improved.

4.4. Problem definition

4.4.1. Generate customer requirements

After the existing service process description, the problem situation is clarified, and it can stimulate the problem definition. As what has been mentioned in section 3.2, at the first stage of identifying customer requirements, the basic function components of the services must be identified. To the shopping mall, the basic functions are providing parking services, providing shopping guidance, providing store reception, provide catering services and other entertainments. Then, according to the relationships between these functions, we can identify the useful functions and harmful functions. The function diagram is shown in Figure 4.3.

Figure 4.3. Function diagram of existing service process

Base on the function diagram and the problem formulator mentioned in section 3.2, we should propose the problem statements to enhance the effectiveness of useful functions and reduce the effectiveness of harmful functions. Thus, 12 problem statements are formulated as follows:

1. Find an alternative way to obtain [UF2: Provide attracting discounts and deductions] that provides [UF1: Bring pleasure shopping experience to customers] and does not cause [HF5: The deductions need to be dealt with at different service locations and sometimes they are forgotten] and [HF6: Customers may not enjoy some discounts, which will cause complaints].
2. Find a way to resolve the contradiction that [UF2: Provide attracting discounts and deductions] should provide [UF1: Bring pleasure shopping experience to customers] and [UF2: Provide attracting discounts and deductions] should not cause [HF5: The deductions need to be dealt with at different service locations and sometimes they are forgotten] and [HF6: Customers may not enjoy some discounts, which will cause complaints].
3. Find an alternative way to obtain [UF1: Bring pleasure shopping experience to customers] that does not require [UF2: Provide attracting discounts and deductions] and will not be influenced by [HF6: Customers may not enjoy some discounts, which will cause complaints].
4. Find a way to eliminate, reduce or prevent the [HF5: The deductions need to be dealt with at different service locations and sometimes they are forgotten]

- to avoid causing [HF6: Customers may not enjoy some discounts, which will cause complaints] under the condition of [UF2: Provide attracting discounts and deductions].
5. Find a way to enhance the effectiveness of [UF3: Provide satisfying catering services].
 6. Find a way to benefit from [HF4: Shopping mall must assist customers to find the most suitable restaurants].
 7. Find a way to enhance the effectiveness of [UF4: Provide shopping guide and store reception services].
 8. Find a way to benefit from [HF3: Detailed direction guidance and products information are needed].
 9. Find a way to resolve the contradiction that [UF6: A shopping mall has its parking lot] should provide [UF5: Provide convenient parking service to customers with cars or motorcycles] and [UF6: A shopping mall has its parking lot] should not cause [HF1: Parking lot without detailed guidance makes customers difficult to find parking space and their cars] and [HF2: Too much waiting time in parking lot].
 10. Find a way to obtain [UF6: A shopping mall has its parking lot] that provides [UF5: Provide convenient parking service to customers with cars or motorcycles] and does not cause [HF1: Parking lot without detailed guidance makes customers difficult to find parking space and their cars] and

[HF2: Too much waiting time in parking lot].

11. Find a way to eliminate, reduce or prevent [HF2: Too much waiting time in the parking lot] to avoid influencing [UF5: Provide convenient parking service to customers with cars or motorcycles] under the condition of [HF1: Parking lot without detailed guidance makes customers difficult to find parking space and their cars].
12. Find an alternative way to obtain [UF5: Provide convenient parking service to customers with cars or motorcycles] that does not require [UF6: A shopping mall has its parking lot] and will not be influenced by [HF2: Too much waiting time in the parking lot].

Usually, the problem formulation can decompose the complicated problems into a series of small problems and thus simplify the problem resolutions. Accordingly, in the result analysis stage, we can integrate these problem statements into five problem solving directions:

1. Provide an efficient way for customers to find available parking space: find a way to resolve the contradiction that the shopping mall should provide the satisfying parking services and should not cause the difficulty in finding parking space or finding back the cars (e.g., design an interface to show the detailed direction guidance to the available parking space).
2. Find an efficient way to reduce customers' waiting time: find a way to

eliminate, reduce or prevent customers waiting time in the parking lot and the shopping mall to avoid influencing the customer satisfaction (e.g., provide smart car finding back system and innovative payment system to shorten the waiting time in queue).

3. Provide an efficient way for customers to find store location: find a way to enhance the effectiveness of shopping guide and store reception (e.g., provide 3D map system to show the precise routines between any two stores).
4. Provide sufficient information for customers to select suitable products and restaurants: find a way to benefit from helping customers to select suitable restaurants (e.g., design a smart device to integrate the detailed information of restaurants and products).
5. Find an effective way for customers to gain discounts and deductions: find an alternative way to provide attracting discounts and deductions that can bring pleasure shopping experience to customers while the deductions will not be calculated at every service locations and no customers will forget or fail to gain them (e.g., integrate all the discounts and deductions together and simplify the procedure to use them).

According to these directions, we can identify the customer requirements of shopping services: 1) Finding parking space, 2) Shorter waiting time, 3) Finding

store location, 4) Gaining enough information, 5) Receiving discounts and deductions.

The problem formulation generates the customer requirements and gives direction to problem resolutions. To carry out the service innovation and break through to another service quality level, U shopping mall decides to develop a new service system with the techniques of mobile app and IoT to improve the customer shopping experience.

4.4.2. Generate service design requirements

The purpose of service design is to improve the shopping service process and eliminate the potential failure points and waiting points. As what has been mentioned in section 3.2, we present the service design requirements in TRIZ service parameters since we can eliminate the failure points and waiting points of service process by improving certain TRIZ service parameters. For example, regarding the failure point 1 “unable to get the information of shopping mall”, if we can improve TRIZ service parameter No.24 “unspecific information”, which means we make the information of shopping mall more clarified and deliver it to customers effectively, the failure point 1 can be solved. For another example, regarding waiting point 1 “too much waiting time in finding parking space”, if we can improve TRIZ service parameter No.25 “waiting time” and No.12 “exterior”,

which means we clarify the exterior of parking lot and reduce the customer waiting time in finding parking space, the waiting point 1 will be solved. The failure points and waiting points and their corresponding service parameters are shown in Table 4.2.

Table 4.2. Failure points & waiting points and their corresponding service parameters

Failure points & waiting points	TRIZ service parameters
F1. Unable to get the information of shopping mall	No.24 Unspecific information
W1. Too much waiting time in finding parking space	No.12 Exterior No.25 Waiting time
F2. Difficult to find store location	No.38 Service intelligent level No.12 Exterior
F3. Difficult to find suitable goods	No.14 Professional knowledge and skill No.28 Communication No.10 Force of supply
W2. Too much waiting time in making payment	No.9 Responsiveness No.25 Waiting time
F4. Failure to get deductions	No.17 Service attitude No.27 Reliability
F5. Difficult to find suitable restaurant	No.24 Unspecific information No.28 Communication
F6. Failure to get discounts	No.13 Service stability No.27 Reliability
F7. Difficult to find cars back	No.38 Service intelligent level No.33 Service system operation
W3. Too much waiting time at the exit	No.25 Waiting time No.38 Service intelligent level

From Table 4.2, we can identify 12 TRIZ service parameters. They are taken as improving parameters in TRIZ contradiction matrix. All these 12 service parameters and their original definition are shown in Table 4.3

Table 4.3. TRIZ parameters and corresponding service parameters

Engineering parameters	Service parameters	Service parameters for shopping mall specific
9.Speed	Responsiveness	Efficiency of shopping mall services
10.Force	Force of supply	The quantity, quality and speed of products supply in the shopping mall
12.Shape	Exterior	The appearance and equipment of shopping mall
13. Stability of the object's composition	Service stability	The stability of the shopping service functions delivery and operation
14.Strength	Professional knowledge and skill	The professional knowledge required for shopping mall services
17.Temperature	Service attitude	Shopping mall staffs are polite, warmly and understanding to customers
24.Loss of information	Unspecific information	Information of shopping mall which the customers cannot receive
25.Loss of time	Waiting time	Waiting time in the shopping process
27.Reliability	Reliability	Reliability of shopping mall services
28.Accuracy of measurement	Communication	The accuracy of demand evaluation
33.Ease of operation	Service system operation	The difficulty of the operation of shopping service system
38.Level of automation	Service intelligent level	Intelligent and automated services provided by shopping mall

4.5. Problem resolution

4.5.1. QFD of customer requirement-service design requirement

With the customer requirements and service design requirements we can deploy the first level of service QFD, in which the “whats” along the vertical axis mean customer requirements and the “hows” along the horizontal axis mean the service design requirements. However, the significance of customer requirements varies according to the customer expectations and that explains why we set the relative

weights of the customer requirements. The rank of importance degree is 1) Gain discounts and deduction effectively. 2) Reduce waiting time. 3) Find parking space. 4) Gain sufficient information. 5) Find store location. Accordingly, the weight of each customer requirement will be set with experts' input of U shopping mall. Then we score the service design requirements according to the strength of correlation between them and customer requirements and 0, 1, 5 and 9 represent "no", "mild", "moderate", and "strong" relationships. Thus, we can multiply scores by weights and then calculate the sum of each column. In this way, we can finally finish the QFD deployment matrix in Table 4.4.

Totally 12 service parameters are graded and six parameters with relatively higher scores are selected, namely "responsiveness (No.9)", "exterior (No.12)", "unspecific information (No.24)", "waiting time (No.25)", "reliability (No.27)" and "service intelligent level (No.38)". These parameters will be marked with "*" in the QFD table and then applied in the TRIZ contradiction matrix analysis.

Table 4.4. QFD deployment analysis of customer requirements and service design requirements

Relative weight	Customer requirements												
		Responsiveness	Force of supply	Exterior	Service stability	Strength	Temperature	Loss of information	Loss of time	Reliability	Accuracy of measurement	Ease of operation	Level of automation
0.35	Gain discounts	5	9	1	5	5	1	9	1	9	9	5	9
0.25	Reduce waiting time	9	5	5	1	5	1	0	9	5	1	1	9
0.15	Find parking space	9	0	9	1	1	0	5	9	9	1	5	9
0.15	Gain information	5	1	9	5	5	5	9	5	1	5	1	9
0.1	Find store location	9	0	9	1	1	1	5	9	9	1	5	9
	Sum	7*	4.8	5.2*	3	4	1.6	5.75*	5.6*	6.8*	4.4	3.4	9*

4.5.2. TRIZ contradiction matrix analysis

From the QFD deployment table we can select six service parameters with higher scores as **improving parameters**, they are “responsiveness (no.9)”, “exterior (no.12)”, “unspecific information (no.24)”, “waiting time (no.25)”, “reliability (no.27)” and “service intelligent level (no.38)”. To improve the intelligent level (IP) of shopping mall services, the service system with smart and automated function modules must be adopted, which means the customers may be able to gain the recommendation automatically or finish payment without staffs’ assistance. However, since the devices partially replace the staffs’ services, customers may feel fewer passions and courtesy from the staffs, so the parameter “temperature (WP)” may get worse. The devices may be difficult for some customers to operate since it is multi-functional and contains a lot of information. Consequently, the parameter “ease of operation (WP)” will get worse. The staffs need to interact with customers, provide discounts or help them make payment with the multi-functional service devices and it is a challenge to staffs’ professional knowledge and service ability, so the parameter “strength (WP)” will get worse.

To improve the reliability (IP) of shopping services, the shopping mall should provide an effective way to prevent customers from the failure to get discounts or deductions; at the same time, they should also provide more discounts to meet

customer expectation. More discounts and reliability of deductions can attract more customers, but it will also bring more pressure to the product supply since the profit of single product decrease and sometimes the hot discounted products are out of stock. Accordingly, the parameter “force of supply (WP)” will get worse. The increasing force of supply will also cause the fluctuation of service delivery, which means the parameter “service stability (WP)” will get worse.

To improve the “loss of information (IP)” of shopping services, the detailed information of products and restaurants should be integrated and presented to customers. However, what kind of information should the shopping mall provide to customers? In other words, what kind of information is this specified customer need? It is a challenge to the evaluation of customer requirements. Thus, the parameter “measurement accuracy (WP)” will get worse.

From the above analysis, we can identify six **worsening parameters**, they are “force of supply (no.10)”, “service stability (no.13)”, “strength (no.14)”, “temperature (no.17)”, “measurement accuracy (no.28)” and “ease of operation (no.33)”.

With the improving parameter and worsening parameters, we can construct the TRIZ contradiction matrix in Table 4.5 by filling the improving parameter in the

column of the matrix and worsening parameters in the row of matrix. Then the most significant innovation principles in the cross nodes of the matrix are selected and underlined.

Table 4.5. TRIZ contradiction matrix

Improving parameters	Worsening parameters					
	No.10	No.13	No.14	No.17	No.28	No.33
No.9	13, <u>15</u>	<u>01</u> ,18	03,08	<u>02</u> , <u>28</u>	<u>28</u> , <u>32</u>	<u>28</u> , <u>32</u>
	19, <u>28</u>	<u>28</u> ,33	14,26	30,36	<u>01</u> ,24	12,13
No.12	<u>10</u> ,35	<u>01</u> ,04	<u>10</u> ,14	14,22	<u>01</u> , <u>28</u>	30, <u>32</u>
	37,40	18,33	30,40	19, <u>32</u>	<u>32</u>	35
No.24	N/A	N/A	N/A	N/A	N/A	22,27
No.25	<u>05</u> , <u>10</u>	03, <u>05</u>	03,18	18,21	<u>24</u> , <u>28</u>	04, <u>10</u>
	36,37	22,35	<u>28</u> ,29	29,35	<u>32</u> ,34	<u>28</u> ,34
No.27	08, <u>10</u>	N/A	<u>11</u> ,28	03, <u>10</u>	03, <u>11</u>	<u>17</u> ,27
	03, <u>28</u>			35	23, <u>32</u>	40
No.38	22,35	<u>01</u> ,18	13,25	<u>02</u> ,19	<u>10</u> ,26	<u>01</u> ,12
				26	28,34	03,34

To resolve the existing problems, nine TRIZ innovation principles are selected according to the frequency of their occurrence. They are “segmentation (no.1), “taking out (no.2)”, “merging (no.5)”, “Preliminary action (no.10)”, “beforehand cushioning (no.11)”, “dynamics (no.15)”, “another dimension (no,17)”, “mechanics substitution (no.28)” and “color changes (no.32)”. Then they will be translated into service resolutions suitable to shopping mall industry, which can be used to generate service functions, and shown in Table 4.6.

Table 4.6. TRIZ innovation principles and corresponding service resolution

Principles	Original definition	Service resolutions for shopping mall industry
1.Segmentation	<ol style="list-style-type: none"> 1. Divide objects into independent parts 2. Make an object easy to disassemble. 3. Increase the degree of segmentation and fragmentation. 	<p>Classify the customers and products</p> <ol style="list-style-type: none"> 1. Recommend the popular goods to customers according to the analysis of sales data. 2. Individualized product recommendation according to customers' profiles.
2.Taking out	<ol style="list-style-type: none"> 1. Separate an interfering part or property from an object, or single out the only necessary part of an object. 	<p>Separate the attractive parts of shopping mall</p> <ol style="list-style-type: none"> 1. Recommend the most unique and popular stores.
5.Merging	<ol style="list-style-type: none"> 1. Bring closer together identical objects; assemble identical or similar parts to perform parallel operations. 2. Make operations contiguous or parallel; bring them together in time. 	<p>Integrate the similar objects in shopping</p> <ol style="list-style-type: none"> 1. All the coupons, consumption points and parking deductions are integrated into a single function module. 2. All the consumption points can be converted into souvenirs, meals or other things immediately after shopping.
10.Preliminary action	<ol style="list-style-type: none"> 1. Perform the required change of an object before it is needed, 2. Pre-arrange objects so that they can come into action from the most convenient place without losing time for their delivery. 	<p>Pre-handle customers demand</p> <ol style="list-style-type: none"> 1. Record customers' cars position in the parking lot. 2. Recharge a certain amount of money in the parking card to avoid cash payment.
11.Beforehand cushioning	<ol style="list-style-type: none"> 1. Prepare emergency means beforehand to compensate for the relatively low reliability of an object. 	<p>Prepare for the possible customer failures</p> <ol style="list-style-type: none"> 1. Provides customers with deduction and discount notification. 2. Automated integration of coupons, member cards and parking deductions.
15.Dynamics	<ol style="list-style-type: none"> 1. Design the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition. 	<p>Turn the static shopping environment to dynamic</p> <ol style="list-style-type: none"> 1. Provide real-time discounts to customers according to the change of customer flows and turnovers. 2. The consumption points can be converted into a greater variety of rewards.
17.Another dimension	<ol style="list-style-type: none"> 1. To move an object in three-dimensional space. 2. Use a multi-story arrangement of objects instead of a single-story arrangement. 	<p>Provide 3D shopping guidance</p> <ol style="list-style-type: none"> 1. Provide 3D direction guidance system. 2. Turn the two-dimensional floor introduction into three-dimensional introduction.
28.Mechanics substitution	<ol style="list-style-type: none"> 1. Replace a mechanical means with a sensory means. 2. Use electric, magnetic and electromagnetic fields to interact with the object. 	<p>Adopt automated shopping service system</p> <ol style="list-style-type: none"> 1. Improve the automatic level of cashier desk service. 2. Provide automated services in the shopping mall, such as self-service payment, in substitute for traditional services.
32.Color changes	<ol style="list-style-type: none"> 1. Change the color of an object or its external environment. 2. Change the transparency of an object or its external environment. 	<p>Bring more light to shopping mall information</p> <ol style="list-style-type: none"> 1. Guide customers to available parking space. 2. Provide detailed information of products and restaurants to assist customers in making choice. 3. Arrange conspicuous signs for the available parking space.

4.5.3. QFD in service function generation

Following the TRIZ innovation principles and corresponding service resolutions, it is not difficult to generate the new service functions. From the “classify customers and products principle”, personalized goods recommendation (F1) can provide information of recommended goods to customers according to their personal profiles, such as their trial and purchase records. Thus, the shopping mall can also deploy the popular goods recommendation (F2) to customers according to the sales data analysis. From the “separate attracting parts principle”, the AR recommendation system (F3) enables customers to discover the most attractive stores with AR module. From the “integrate similar objects principle”, smart coupon system (F4) can integrate all the coupons, member cards and deductions into a single function module to prevent the customers from forgetting to bring them. Also, the instant exchange (F5), which allows customers to convert the consumption points to souvenirs, meals or other prizes immediately after shopping can also be adopted. From the “pre-handle demand principle”, the car position system (F6) can record the customers’ cars position when they leave the parking lot to prevent them from forgetting their cars position. The parking card (F7) with a certain amount of money can free the customers from cash payment. From the “prepare for failure principle”, the shopping mall can provide the notification of attractive discounts and deductions (F8) to customers. Thus, the deductions can also be obtained by customers automatically (F9) after payment. From the “turn static to

dynamic principle”, the shopping mall should allow customers to convert the consumption points to a greater variety of rewards (F10), from souvenirs to daily necessities or meals in restaurants. Also, the real-time discounts system (F11) enables the stores to interact with customers with Bluetooth devices, and the discounts can be provided to customers or adjusted whenever the stores need. From “provide 3D guidance principle” the shopping mall can switch the two-dimensional floor introduction to three-dimensional map (F12). Thus, the mobile devices with 3D floor guidance system (F13) can also provide the direction guidance. From the “automated service system principle”, the shopping mall can upgrade their cashier services by making the cashier desk more intelligent (F14) to shorten customer waiting time, or adopt the automatic payment system (F15). From “bring light to information principle”, the parking lot can arrange conspicuous signs (F16) for the available parking space or adopt smart parking system (F17), which can provide the customers with direction guidance to available parking space. Furthermore, the smart introduction system (F18) can be applied to introduce the detailed information of restaurants, such as the rating of courses, the environment or the length of the queue, to customers.

With the service resolution and service functions we can deploy the second level of service QFD, in which the “whats” along the vertical axis mean the service resolution and the “hows” along the horizontal axis mean the service functions. We

adopt the same calculation method as described in section 4.5.1 and the QFD deployment matrix is shown in Table 4.7 and Table 4.8.

Totally 18 service functions are graded and 10 functions with relatively higher scores are selected, namely: “personalized goods recommendation (F1)”, “AR system (F3)”, “smart coupon system (F5)”, “car position system (F6)”, “automated deductions (F9)”, “real-time discounts system (F11)”, “3D floor guidance (F13)”, “automated payment (F15)”, “smart parking system (F17)” and “smart introduction system (F18)”. These selected service functions are marked with “*” in the QFD deployment matrix and give directions to the new service system design.

Table 4.7. QFD deployment analysis of service resolutions and service functions (1)

Relative weight	Service resolutions	Service functions								
		Personalized goods recommendation	Popular goods recommendation	AR system	Instant exchange	Smart coupon system	Car position system	Parking card	Notification of deductions	Automated deductions
0.12	Classify customers	9	1	5	0	5	9	5	5	5
0.12	Separate attracting parts	9	5	9	5	5	1	0	5	5
0.12	Integrate similar objects	5	5	9	5	9	0	0	1	9
0.12	Pre-handle demand	5	0	1	1	1	9	9	1	5
0.12	Prepare for failure	0	0	5	5	9	9	5	9	9
0.12	Turn static to dynamic	5	0	5	5	5	1	0	1	9
0.12	Provide 3D guidance	0	0	9	0	0	9	0	0	0
0.12	Automated service system	9	9	9	0	9	9	5	5	9
0.12	Bring light to information	9	9	9	0	5	9	0	5	5
	Sum	6.12*	3.48	7.32*	2.52	5.76*	6.72*	2.88	3.84	6.72*

Table 4.8. QFD deployment analysis of service resolutions and service functions (2)

Relative weight	Service resolutions	Service functions								
		Greater variety of rewards	Real-time discounts system	3D map	3D floor guidance	Intelligent cashier desk	Automated payment	Conspicuous signs	Smart parking system	Smart introduction system
0.12	Classify customers	5	5	0	5	0	5	0	1	9
0.12	Separate attracting parts	5	5	0	5	0	0	5	5	5
0.12	Integrate similar objects	5	5	0	0	0	5	0	0	5
0.12	Pre-handle demand	1	9	5	5	1	5	5	5	1
0.12	Prepare for failure	1	0	5	5	1	5	5	5	5
0.12	Turn static to dynamic	1	9	0	9	5	5	0	5	9
0.12	Provide 3D guidance	0	0	9	9	0	0	0	9	0
0.12	Automated service system	0	9	0	9	5	9	0	9	9
0.12	Bring light to information	5	5	9	9	0	1	5	9	9
	Sum	2.76	5.64*	3.36	6.72*	1.44	4.2*	2.4	5.76*	6.24*

4.6. New service system design with Apps and interactive signage

After analyzing the service functions selected from QFD, we discuss with shopping mall manager and the mobile service provider about the new service system design. To bring convenience to customers, we decide to design a smart shopping app so that the customers can enjoy the intelligent shopping service with their smart phone. On the one hand, the shopping mall thinks that the new shopping app should provide as many service function as possible to improve the shopping service; on the other hand, the mobile service provider, also the developer of this app, want to simplify the app structure and make it more feasible in technology. Considering the opinions of both sides, we decide to integrate 10 functions selected by QFD into several function modules. And these function modules should solve all the failure points and waiting points to improve the shopping service process.

- To solve failure point 1 “difficult to gain information”, we can adopt F18 “smart introduction” and F3 “AR system”, which means customers can find out the stores or services they are interested in with AR system since the app can show the introduction and recommend the stores to them. Accordingly, we can integrate these two functions into a function module. We call this function module “City Encyclopedia”.
- Waiting point 1 “difficult to find parking space” and failure point 7 “difficult to find car back” both occur in parking stage. To solve these two points, we

can adopt F6 “car position system” and F17 “smart parking system”, which means the app can record customers’ car position and give them detailed direction guidance when they find their cars or parking space. Accordingly, we should integrate these two functions into a function module. We call this function module “Smart parking”.

- To solve failure point 2 “difficult to find store location”, we can adopt F13 “3D floor guidance”, which means the app will show the store location and routines in 3D map to help customers find the stores. Accordingly, we should integrate this function into a function module. We call this function module “Mall directory”.
- Failure point 4 “failure to get deduction” and failure point 6 “failure to get discounts” are problems of gaining discounts. To solve these two points, we can adopt F5 “smart coupon system”, F9 “automated deductions”, F11 “real-time discounts system”, which means customers can receive the discounts and deductions automatically when they wander around the mall or finish payment. Accordingly, we should integrate these three functions into a function module. We call this function module “Shiok”.
- Waiting point 2 “too much waiting time in making payment” and waiting point 3 “too much waiting time in exit” both occur in payment stage. To solve these two points, we should adopt F9 “automated deductions” and F15 “automated payment”, which means customers can make payment in

self-service way instead of go to cashier desk. Accordingly, we should integrate these two functions into a function module. We call this function module “Smart pay”.

- Failure point 3 “difficult to find suitable goods” and failure point 6 “difficult to find suitable restaurant” are problems of finding suitable stores, goods and services in shopping mall. To solve these two points, we should adopt F1 “personalized goods recommendation” and F18 “smart introduction system”, which means customers can get detailed information of recommended goods, stores and services. Accordingly, we should integrate these two functions into a function module. We call this function module “Smart recommendation”.

Now we generate six function modules of the shopping service app by integrating the service functions. In Table 4.9 we show the description and main functions of the six function modules. After proposing the app function modules, we finish the design of the new shopping service system.

Table 4.9. Function modules of the mobile app

App modules	Service functions	Main functions
Module1: City Encyclopedia	F3, F18	1. This module bases on interactive AR system and allows customers to discover the surrounding area. 2. Recommend the attracting and high rated stores and services.
Module2: Smart parking	F6, F17	1. Direct the cars to the empty parking grids. 2. Record the cars location and provide cars finding guidance.
Module3: Mall directory	F13	1. Show the detailed routine guidance between any two locations in the shopping mall and present the routines on the 3D map.
Module4: Shiok	F5, F9, F11	1. This module integrates all the member cards, coupons, parking deductions and consumption points 2. Receive the real-time discounts provided by the stores nearby
Module5: Smart pay	F9, F15	1. This module allows customers to make payment by scanning QR code and they can also pay the parking fee on the self-service machine. 2. The parking deductions, consumption points, coupons and other prizes will be automatically integrated into Shiok module once after the payment is finished.
Module6: Smart recommendation	F1, F18	1. Construct customers' personal profile according to their trial and purchase record. 2. Recommend the suitable products based on the customers' profile and maximize the discounts. 3. Provide detailed information of restaurants, including the rating of courses, the environment, the service attitude and the length of the queue.

4.7. New service process description

With the new service system U shopping mall can eliminate the failure points and waiting points. Thus, the service quality is improved, and the service process can be reconstructed. The new service process is depicted in Figure 4.4, and the depiction of new service process is described as follows:

1. When customers wander around Xinyi district, they can open the mobile app and discover the interesting stores, services, and discounts with AR module.
If they are attracted, they will step into the shopping mall.
2. If customers drive to shopping mall, they should find the parking lot at first.

When the screen outside the parking lot shows there is empty parking grid, then they can drive in and find the available parking grid with the direction guidance of the smart parking module in the mobile app instead of circling around the parking lot. After parking their cars, the customers will find the entrance and enter the shopping mall.

3. After entering the shopping mall, customers can get in touch with the introduction of specialized products, services, and promotions provided by “My Wall” system in the hall. It is possible for them to figure out something attractive and then they will head to the relevant floor to find those products and services. If there is nothing attractive, they may head to the B2 floor to find delicious food or sales.
4. If customers have target store, they can open the mobile app and find the store location with the guidance of 3D map system. If they do not have a target, they can just wander around the floor and receive the real-time discounts provided by the stores nearby with iBeacon. Then they can find the interesting stores and go shopping inside.
5. When customers enter the stores, they tend to have trials. If they are not satisfied with the products they can find similar goods in other stores; if they are satisfied with the products and willing to pay, they can just scan the QR code provided by stores to make payment with smart payment module in the mobile app. After making payment the consumption points, coupons and

deductions will be automatically integrated into the app. Then, if customers want to find other suitable goods to match with what they have bought, or to maximize the discounts, they can go shopping in other stores with the smart recommendation module in the app.

6. Typically, customers would like to have meals after shopping. With the smart recommendation module in the app, they can figure out the detailed information of restaurants, including the rating of courses, the environment, the service attitude and the length of the queue, etc. Then customers can select suitable restaurants according to their fancy. After finishing the meal customers can make payment by scanning QR code with the coupons and member cards in the app and then the deductions will be obtained automatically by the app.

7. Finally, the customers will leave the shopping mall. To customers who walk they will just head to the first floor, find the gate and leave the mall. To customers who take the public transportation such as bus or subway, they can go to the B2 floor to find the transfer station. To customers who drive they will first go to the entrance of parking lot and insert the parking card into a self-service machine, scan the QR code to pay the parking fee and then get the card back. The deductions will also be used automatically. Then they can open the app, which has already recorded their cars' location, and find their cars with the direction guidance. After getting the car back, they

will drive to the exit and insert the parking card into the fence machine.

Since the parking fee has been paid, they can directly leave the parking lot without waiting.

Note: F: Failure point; W: Waiting point

Figure 4.4. Service blueprint of new shopping mall service process

4.8. The maturity level analysis of new service process

In section 3.4 the 12 dimensions of progress areas in the service maturity model have been interpreted, and the maturity level of existing service process has also been evaluated in section 4.3. So, in this part, we will discuss the maturity level of the new service process to find out the gap between the new one and the existing one. In this way, we can also evaluate the effects brought by the service reconstruction. The evaluation of maturity level of new service process is presented as follows:

- Regarding “strategy goals”, with new service system and service process reconstruction, U shopping mall switches their target from “do better in competition” to “do what the competitors cannot do” since till now there is no other shopping mall can provide such intelligent shopping services. Accordingly, the maturity level of this dimension is level 5
- Regarding “strategy specification”, the new service process is based on the target customer research and designed to improve the customer shopping experience. Accordingly, the maturity level of this dimension is level 4.
- Regarding “resource distribution”, new service system can connect all the stores and provide the smart recommendation, which can weaken the independence of stores’ operation and attract more customers. The real-time discounts system can help stores balance the turnovers of peak and trough,

which can reduce the waste of resources. Accordingly, the maturity level of this dimension is level 3.

- In terms of “systematic procedure”, the service process of U shopping mall is highly standardized with strict regulation on products and service attitude. There is also a standard process of new service design and development. Accordingly, the maturity level of this dimension is level 3.
- Regarding “formal paperwork”, the new service system will construct the customer profiles to provide the individualized services, which means there will be detailed documentation of customer behavior, such as trials and purchase records, the rating of stores and restaurants, etc. The documents are more diversified than before. Accordingly, the maturity level of this dimension is level 4.
- Regarding “responsibility assignment”, to design the new service system, U shopping mall has organized a formal team with the professionals. There are clear divisions and formal responsibilities for all the team member. Accordingly, the maturity level of this dimension is level 3.
- Regarding “organization culture”, U shopping mall has paid attention to service knowledge creation and emphasizes the collection of service records, which can be applied in the evaluation of service quality. The evaluation results will also be shared among the staffs. Accordingly, the maturity level of this dimension is level 4.

- Regarding “processes”, the new service system turns the base of knowledge creation from staffs’ experience to the smart app records, which is more intuitive and precise. Furthermore, the data and analysis can be easily shared among staffs with mobile technology. Accordingly, the maturity level of this dimension is level 3.
- Regarding “service technology”, the new service system has significantly improved the intelligence level of shopping services with more advanced technologies such as AR, 3D guidance, position record, and iBeacon, etc. Accordingly, the maturity level of this dimension is level 4.
- In terms of “customer role”, currently U shopping mall takes customers as the research objects and the source of information. The services are designed and improved according to the research on customers. Accordingly, the maturity level of this dimension is level 3.
- Regarding “involvement stages”, the new service system enhance the interaction between customers and shopping mall. On the one hand, the shopping mall can collect the real-time data of customers and alter the strategy, on the other hand, the customers can get the detailed information of shopping mall and provide the feedback whenever they want. The customers are involved in the whole process of service development. Accordingly, the maturity level of this dimension is level 4.

- Regarding involvement method, with the new service system, U shopping mall can collect customers demand with the mobile app records, which is more intuitive and precise than the traditional ways like interview or questionnaire. U shopping mall also applies some structured tools, such as QFD, in customer demand analysis. Accordingly, the maturity level of this dimension is level 4.

The comparison radar chart of the existing service process and new service capability is shown in Figure 4.5.

Figure 4.5. Comparison of existing service process and new service process

The maturity grid of the new service process can be figured out and shown in Table 4.10.

Table 4.10. Maturity grid of new service system

Maturity level	Progress area			
	Strategy management	Process formalization	Knowledge management	Customer involvement
Maturity level 1	Achieved	Achieved	Achieved	Achieved
Maturity level 2	Achieved	Achieved	Achieved	Achieved
Maturity level 3	Achieved	Achieved	Achieved	Achieved
Maturity level 4				Achieved
Maturity level 5				

It can be inferred that the maturity level of the whole service process has been improved from level 2 to level 3. Also, the maturity level of every progress area has been improved, which means the new service system has comprehensively enhanced the service capability of U shopping mall.

4.9. Research validation

During the proof of service stage there had been 68 stores participating the service innovation and 235 customers downloading the mobile app. We had tracked the test result by measuring the customer waiting time and interviewing the customers who use the new service system. The average waiting time of these customers in making payment had been shortened from 10 minutes to 4 minutes. The complaint rate of catering services had decreased by 15 percent while the satisfaction rate of parking services had increased by 25 percent.

Chapter 5. Conclusion

5.1. Conclusion

The objective of this study is to develop a systematic framework as a new service design approach and to verify and validate this approach by applying it to design new services for a case company with its specific innovation needs. This research proposes a conceptual service design approach, 4D service design model, in research framework, which can be applied in the context of different problems.

The case study analyzes the TRIZ or non-TRIZ methods of a four-phase of case description, problem definition, problem resolution, and solution evaluation. Therefore, an effective science-based, systematic procedure based on both TRIZ and other methods is proposed in 4D service design model.

This study depicts the service process of the shopping mall with service blueprint. The problems are analyzed and corresponding service resolutions are formulated based on TRIZ methodology. A new mobile app with six function modules is also designed to reconstruct the service process. To the customers, the new service system significantly improves their shopping experience. The smart pay module, smart parking module and mall directory module can shorten customers waiting

time since they no longer need to cycle around to find the location or wait before the cashier desk to make payment. And in validation period, we could find that the average waiting time of customers significantly shrunk. The smart recommendation module and City Encyclopedia module enable customer to get detailed information efficiently. The Shiok module bring more discounts and deductions to customers since they can receive the real-time discounts when they are walking and they no longer worry about forgetting the deductions or coupons. In validation period, we could find the customer satisfaction rate significantly improved. To shopping mall, the indoor guidance is enhanced by the mobile application, which can provide the direction guidance, the detailed information of goods or restaurants, real-time discounts and recommendation.

5.2. Contribution

In other studies about service design, authors seldom adopt over three methodologies. Most of them just combine QFD with TRIZ, or simply use only one methodology. For example, Albrecht [11] only adopts service blueprint to improve the tourism service. In this study, we combine four methodologies in 4D model, which contributes a holistic, interdisciplinary and integrated service design method that accommodates the nature of problem-solving and solution-finding, and enables service design approach integration from the case analysis, problem definition and problem resolution through solution evaluation phases. 4D model also synthesizes

contributions from the traditional field of TRIZ service-design knowledge system and the emerging field of the non-TRIZ service design knowledge system.

In the background analysis, the research analyzes the enterprise's background, process, and disadvantages with service maturity analysis. In the problem definition stage, the research analyzes the enterprise's problem using problem formulator and TRIZ service parameters. In the service resolution stage, the QFD, contradiction matrix, 40 principles of TRIZ are conducted, including the principles of segmentation, taking out, merging, preliminary action, beforehand cushioning, dynamics, another dimension, mechanics and color changes. In the solution evaluation stage, new indoor-guidance networking solutions, "U shopping service" mobile Apps, are proposed as an ideal result, according to the principles generated in the problem definition stage. A new service blueprint is depicted, and a service maturity model is analyzed to evaluate the new service process.

The U shopping service apps bring the main benefits of better customer interaction and relations, improved experiential marketing aspects and higher profits. For the generalization of the proposed multi-service design to other industries, six proposed functions are classified according to their purposes and characteristics. City Encyclopedia provides the concept of informing the ideas to discover the surrounding area. Smart parking personalized recommendation service function to

guide customers to high rated stores and services. Mall directory shows the detailed routine guidance and show the detailed routine guidance between any two locations in the shopping mall and present the routines on the 3D map. Shiok integrates all member cards, coupons, parking deductions and consumption points. Smart pay provides a scan and pay function. Smart recommendation can recommend the suitable products based on the customers' profile. They can both be applied generally to the shopping mall industry and even to the other retail service industry. The new service offers entirely new processes of ordering and radical change of the existing system, well in advance of existing systems in the industry.

This paper is an empirical case study of a shopping mall in Taipei, and it tries to improve the service quality and shopping experience. It enriches the literature of shopping mall service design by extending the application of TRIZ methodology and QFD approach into shopping mall area. By evaluating the shopping service capability with service maturity model, this study extends this theoretical approach to practical application.

5.3. Limitations

The main limitation of this study is that it lacks quantitative analysis. Subject to the condition such as the difficulty to get detailed customer data and records, in service process analysis we identify the failure points and waiting points according to our

observation of shopping process and the opinions from staffs and experts, which means our judgements are based on experience; in problem definition stage, we adopt problem formulator, a typical qualitative method, to generate customer requirements. In other cases, Lee [7] adopts the quantitative methodology Lean Six Sigma to measure and analyze the time consumption in every segment of parking service process, thus, he can analyze and generate the problems of parking service very accurately and convincingly. Consequently, to make the demand analysis more accurate and convincing, more quantitative methodologies are needed.

Regarding service maturity model, we evaluate the service process of U shopping mall and assess the service maturity level according to our own experience. But our concepts are very limited, so our assessment may not be very professional and objective. To improve the authority of this study, we need more expertise in the evaluation chapter. Therefore, Delphi method is suitable to collect the experts rating of every dimension of the maturity model, then we can integrate the experts' opinion and evaluate the service maturity level. The expertise will make the outcome of this study more reliable.

5.4. Future study

The outcome of this study is a shopping service app with six function modules. However, if we want to achieve these functions and provide intelligent services to

customers, we also need to deploy the service system in shopping mall to support the operation of app. In the future study, we will discuss how to deploy the new service system in the shopping mall, including the technology and resources it needs, its working process and how it can support the functions of shopping service app.

Intelligent service is a worldwide trend so the study about smart shopping service should not be limited in Taiwan. In the future study, we will discuss the feasibility of the application of this intelligent shopping service methodology in other places in the world. For example, we can discuss how to provide the intelligent shopping services in Singapore.

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